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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the application of	:	Hudson, John E.
Serial No.	:	09/849,927
Filed	:	May 4, 2001
For	:	Equaliser For Digital Communications Systems and Method of Equalisation
Examiner	:	Pathak, Sudhanshu C.
Art Unit	:	2634
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I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450," on January 6, 2006.
Name of person signing Minnie Wilson
Signature Minnie Wilson

APPEAL BRIEF

Honorable Director of Patents and Trademarks
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This appeal is from the Examiner's final Office Action mailed June 28, 2005 in which all pending claims (namely Claims 1 to 4, 6 to 21 and 23 to 29) were rejected. A timely Notice of Appeal was filed with the required fee with a request for Pre-Appeal Brief Review, and given the Notice of Panel Decision from Pre-Appeal Brief Review, this brief is due January 6, 2006.

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This brief is being filed along with the required $500 fee pursuant to 37 C. F. R. § 41.20(b)(2).

(i) Real Party in Interest

This application is assigned to Nortel Networks Limited, who is the real party in interest.

(ii) Related Appeals and Interferences

There are no related appeals or interferences.

(iii) Status of Claims

This application was filed with claims 1 to 29. In the response of February 18th, 2005, claims 4 and 22 were cancelled and claims 1, 10, 13, 16, 17, 19, 28 and 29 have each been amended to recite features patentably distinguishing the invention over the prior art of record. Claims 1 to 4, 6 to 21 and 23 to 29 are being appealed.

(iv) Status of Amendments

No further amendments to the claims were made in the after final response of August 25, 2005, which response was entered by the Examiner, so the claims now pending have all been considered by the Examiner and finally rejected. It is the rejection of these claims as set forth in the final Office Action mailed June 28, 2005 that is appealed. All the pending claims 1 to 4, 6 to 21 and 23 to 29 as amended during the prosecution of the application, are set forth in the Claims Appendix.

(v) Summary of Claimed Subject Matter

The invention as presently claimed is concerned with a method (claim 1) of equalizing a data stream received over a dispersive communications channel from a plurality of transmit antenna elements, where said data stream is generated from a plurality of space time coded (STC) signals (data streams). It should be noted that space time signalling was first mooted circa 1998. Space time coding (STC) and, in particular, space time transmit diversity (STTD) was proposed for mitigating the effects of fading and coloring of a non-dispersive communications channel (present application, page 2, line 30 to page 3, line 3). In STC, at least two data (symbols or chips) streams are transmitted at the same time from different, respective antenna elements. Hence, the at least two STC data streams are formed in both time and space. In the case where there are only two STC data streams, one data stream is formed from the complex conjugates of the symbols comprising the other of the data streams. Consequently, it is inherent in such an arrangement that, where the communications channel is dispersive, this will result in time-overlapping of received signals and training sequences between the data streams and even within such streams. However, despite this, in the present invention it has been found to not be necessary to insert time gaps into the transmitted STC data streams as suggested by prior art arrangements.

The method of the present invention makes a useful contribution to the art of STC and STTD in that it provides a computationally simpler method of equalizing a communications channel than those conventionally employed in the art of STC and STTD and, for a dispersive communications channel, without the need to insert time gaps into simultaneously transmitted STC data streams. The insertion of time gaps disadvantageously leads to the slower processing times inherent in the processes taught by prior art arrangements.

(vi) Grounds of Rejection To Be Reviewed on Appeal

There are three rejections at issue:

1. the rejection of claims 1, 2, 4, 6 to 14, 15, 16, 19 to 21, 23 to 27 and 29 under 35 U.S.C. 103(a) as being unpatentable over the Applicant Admitted Prior Art (AAPA) (application specification, page 2, lines 2 to 28) in view of US Patent Number 4058713 to DiToro; and

2. the rejection of claims 3 and 28 under 35 U.S.C. 103(a) as being unpatentable over the Applicant Admitted Prior Art (AAPA) in view of US Patent Number 4058713 to DiToro and further in view of US Patent Number 4141072 to Perreault;

3. the rejection of claims 17 and 18 under 35 U.S.C. 103(a) as being unpatentable over the Applicant Admitted Prior Art (AAPA) in view of US Patent Number 4058713 to DiToro and further in view of US Patent Number 4707841 to Yen et al.

(vii) Argument

Ground 1:

In *ex parte* examination of patent applications, the Patent and Trademark Office bears the burden of establishing a *prima facie* case of obviousness. MPEP § 2142; *In re Fritch*, 972 F.2d 1260, 1262, 23 U.S.P.Q.2d 1780, 1783 (Fed. Cir. 1992). The initial burden of establishing a *prima facie* basis to deny patentability to a claimed invention is always upon the Patent and Trademark Office. MPEP § 2142; *In re Oetiker*, 977 F.2d 1443, 1445, 24 U.S.P.Q.2d 1443, 1444 (Fed. Cir. 1992); *In re Piasecki*, 745 F.2d 1468, 1472, 223 U.S.P.Q. 785, 788 (Fed. Cir. 1984). Only when a *prima facie* case of obviousness is established does the burden shift to the applicant to produce evidence of nonobviousness. MPEP § 2142; *In re Oetiker*, 977 F.2d 1443, 1445, 24 U.S.P.Q.2d 1443, 1444 (Fed. Cir. 1992); *In re Rijckaert*, 9 F.3d 1531, 1532, 28 U.S.P.Q.2d 1955, 1956 (Fed. Cir. 1993). If the Patent and Trademark Office does not produce a *prima facie* case of unpatentability, then without more the applicant is entitled to grant of a patent. *In re Oetiker*, 977 F.2d 1443, 1445, 24 U.S.P.Q.2d 1443, 1444 (Fed. Cir. 1992); *In re Grabiak*, 769 F.2d 729, 733, 226 U.S.P.Q. 870, 873 (Fed. Cir. 1985). A *prima facie* case of obviousness is established when the teachings of the prior art itself suggest the claimed subject matter to a person of ordinary skill in the art. *In re Bell*, 991 F.2d 781, 783, 26 U.S.P.Q.2d 1529, 1531 (Fed. Cir. 1993). To establish a *prima facie* case of obviousness, three basic criteria or tests must be met. **(A)**, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. **(B)**, there must be a reasonable expectation of success. **(C)**, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed invention and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. MPEP § 2142.

While prior art reference DiToro (US4058713) does disclose converting a received message signal and a test signal to the frequency domain via Fast Fourier Transformation (FFT) in order to equalise the received message signal in the frequency domain prior to re-transforming the resultant equalized message signal back to the time domain, it does not disclose a method of equalizing a received message signal where said signal is generated from a <u>plurality</u> of received data streams received from <u>a plurality of transmit antenna elements</u> and where said data streams are <u>space time coded (STC)</u> data streams.

In the equalization method of DiToro, the message signal is received from a single antenna element and thus comprises a single, partitioned signal stream transmitted in burst or frame by frame form. Each frame comprises the message followed by a test signal. It is necessary in the method of DiToro to avoid overlapping the received message frames and the test signals due to the dispersion, i.e. time-spreading, encountered in the communications channel carrying the message frames and test signals. This is achieved by providing time gaps between the message frames and test signals (Abstract). The time gaps provided between the message frames and test signals are such that, notwithstanding the time-spread encountered in the transmission process, the bursts (message frames and test signals) do not overlap in time at the receiver (column 3, lines 59 to 66). In other words, the time gaps must be made sufficiently long to account for the maximum possible time-spread that may be encountered by the message frames and test signals in order to ensure that no overlapping of the bursts occurs at the receiver. This is an inefficient use of the communications channel.

In contrast and as already described, the data stream to be equalized in the arrangement of the present invention is received as a plurality of STC data streams over a <u>dispersive</u> communications channel from a plurality of transmit antenna elements. Hence, the plurality of STC data streams are formed in both time and

space. Consequently, it is inherent in such an arrangement that dispersion in the communications channel will result in time-overlapping of received signals and training sequences between the STC data streams and even within such streams. However, despite this, in the present invention it has been found to not be necessary to insert time gaps into the transmitted STC data streams as required by DiToro, thus providing a useful advance over the combination of DiToro and AAPA.

The present invention therefore proposes using space time coding in a dispersive communications channel contrary to received wisdom in the field of STC and STTD in order to equalize a received signal. A skilled person would not seriously contemplate modifying the Applicant Admitted Prior Art (AAPA) which utilizes STC in a non-dispersive communications channel with the equalization method disclosed in DiToro for a number of reasons. The equalization method of DiToro is applicable to a single, partitioned signal transmission over a dispersive communications channel in which time gaps must be inserted between message frames and test signals. It is a straightforward process to determine the maximum possible time-spread that would be encountered by message frames and test signals in a communications channel carrying a single transmission signal and to then partition said transmission signal to insert time gaps sufficiently large to mitigate the effects of dispersion in the communications channel. However, in a dispersive, i.e. time-spreading, communications channel, it is inherent that simultaneous STC data streams received at a receiver will result in overlapping of message signals and training sequences at least between the data streams, if not within the streams. This problem is exacerbated in an exponential fashion as the number of simultaneous STC data streams increases from two. Consequently, the insertion of time gaps into any or all of the streams will never completely prevent overlapping of message signals and training sequences. Therefore, a skilled person would not find motivation in DiToro to modify the AAPA using the arrangement disclosed in DiToro to arrive at the method of the present invention in view of the inability to insert effective time gaps into the plurality of STC data streams to prevent overlapping at the receiver.

Applicant submits that it is only possible to arrive at the method of the present invention as defined by independent claim 1 starting with the AAPA and in view of DiToro through the impermissible use of hindsight.

Applicant registers here its disappointment that, despite the detailed and expansive arguments put forward by Applicant traversing the original rejection of claims 1, 2, 4, 6 to 14, 16, 19 to 21, 23 to 27 and 29 as being unpatentable over Applicant's Admitted Prior Art (AAPA)in view of DiToro (US4058713), the final Office Action was issued with essentially the same ground of rejection but including a "Response to Arguments" section that amounted to one short paragraph that suggests that Applicant's arguments have never been fully or properly considered in the examination procedure.

Merely using the "Response to Arguments" section to point to the fact that the feature comprising the main amendment included in the independent claims of Applicant's first response to the first Office Action mailed November 19, 2004 can be found in one of the pieces of applied prior art (in this case AAPA) does not meet the burden incumbent on the USPTO, as established by law, of supporting a rejection under 35 U.S.C. §103(a). It is necessary that each claim is considered as a whole and that the three tests established in law and denoted herein as **(A)**, **(B)** and **(C)** respectively are applied thereto. It is also necessary that the conclusions drawn from the application of said tests to each claim is explained to the Applicant by way of demonstrating that the Applicant's arguments have been fully considered but are not persuasive.

For example, the Examiner has never explained why a skilled person would be motivated to apply the technique of space time coding (STC) and, in particular, space time transmit diversity (STTD), which was originally designed for mitigating the effects of fading and colouring of a <u>non-dispersive</u> communications channel (present

application, page 2, line 30 to page 3, line 3) such as encountered in AAPA to the dispersive communication system of DiToro or vice-versa. Or, even if the skilled person did for some reason become motivated to try applying the STC technique to DiToro, why he/she would then consider going against the teaching of DiToro by removing one of the essential elements (i.e. the inserted time gaps) of the system of DiToro in order to arrive at the present invention. It should be remembered that the STC technique was first mooted in 1998 for non-dispersive systems and, if the Examiner's rejection is to stand, one is to consider that it would have been obvious to apply the 1977 teaching of DiToro, which relates to dispersive systems, to the !998 teaching of AAPA which is concerned with non-dispersive systems. Given that the present invention is in a fast moving and competitive field of technology, one wonders why it did not happen sooner if it were so obvious! The answer, clearly, is that it was not, and the Examiner's rejection is simply an impermissible use of perfect hindsight.

Ground 2:

The forgoing submission relating to Ground 1 is equally pertinent to the rejection of claims 3 and 28.

Ground 3:

The forgoing submission relating to Ground 1 is also equally pertinent to the rejection of claims 17 and 27.

Reversal of the Examiner is therefore clearly in order and is solicited.

January 6, 2006

Respectfully submitted,

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Claims Appendix

1. A method of channel equalisation comprising:

receiving a data stream generated from a plurality of space time coded (STC) data streams received from a plurality of transmit antenna elements;

generating via a fast transform a packet spectrum of at least a portion of the data stream, the packet spectrum being a transform domain representation;

receiving a training sequence for a channel through which the data stream has been sent and assessing a channel impulse response for the channel based on the training sequence;

generating via a fast transform a channel impulse response spectrum in the transform domain for the channel impulse response;

equalising the packet spectrum with the channel impulse response spectrum to produce an equalised packet spectrum in the transform domain; and

converting the equalised packet spectrum into time domain equalised data for recovery of information.

2. The method of claim 1, wherein equalising the packet spectrum further includes:

deconvolving transmitted and received data streams with respect to channel impulse response spectra, thereby to produce at least one equalised data stream.

3. The method of claim 1, wherein equalising the packet spectrum includes performing a minimum mean square error (MMSE) spectral ratio comparison.

4. The method of claim 1, further comprising truncating the channel impulse response spectra to limit processing and enhance accuracy associated with equalising the packet spectrum.

5. (cancelled)

6. The method of claim 1, wherein assessing the channel impulse response for the channel based on the training sequence further includes assessing a matrix-valued channel impulse response.

7. The method of claim 1, further comprising receiving the data stream at a plurality of receive antenna elements.

8. The method of claim 1, wherein the fast transform is a Fourier transform.

9. The method of claim 1, wherein the data stream is distributed in slots across a plurality of frames, each slot including the training sequence.

10. The method of claim 1, wherein the data stream is arranged such that a code-word level construction of a Space Time Transmit Diversity (STTD) signal is modified to a chip-level construction in which Code Division Multiple Access (CDMA) code words are interleaved at a chip level instead of being transmitted whole in sequence.

11. The method of claim 1, wherein the data stream is a slot of a data frame and the method further comprising reading the slot into memory.

12. The method of claim 11, wherein said at least a portion of the data stream includes a packet overlap.

13. A computer program product for a processor of a channel equaliser, the computer program product comprising:

code that supports reception of a data stream generated from a plurality of space time coded (STC) data streams received from a plurality of transmit antenna elements;

code that generates via a fast transform a packet spectrum of at least a portion of the data stream, the packet spectrum being a transform domain representation;

code that supports reception of a training sequence for a channel through which the data stream has been sent and code that assesses a channel impulse response for the channel based on the training sequence;

code that generates via a fast transform a channel impulse response spectrum in the transform domain for the channel impulse response;

code that equalizes the packet spectrum with the channel impulse response spectrum to produce an equalised packet spectrum in the transform domain; and

code that converts the equalized packet spectrum into time domain equalized data for recovery of information;

wherein the codes reside in a computer readable medium.

14. The computer program product of claim 13, further comprising:

code that deconvolves transmitted and received data streams with respect to channel impulse response spectra, thereby to produce at least one equalised data stream, the code that deconvolves associated with the code that equalizes the packet spectrum.

15. The computer program product of claim 13, further comprising:

code that assesses a matrix-valued channel impulse response, said code associated with the code that assesses the channel impulse response for the channel based on the training sequence.

16. The computer program product of claim 13, further comprising:

code that modifies a code-word level construction of a Space Time Transmit Diversity (STTD) signal is modified to a chip-level construction in which Code Division Multiple Access (CDMA) code words are interleaved at a chip level instead of being transmitted whole in sequence.

17. An integrated chip having a controller programmed to provide a channel equalisation function, the controller comprising:

a first receiver chain arranged, in use, to receive a data stream generated from a plurality of space time coded (STC) data streams received from a plurality of transmit antenna elements;

a first fast transform function arranged to generate a packet spectrum of at least a portion of the data stream, the packet spectrum being a transform domain representation;

a second receiver chain arranged, in use, to receive a training sequence for a channel through which the data stream has been sent;

a channel impulse response estimator for assessing a channel impulse response for the channel based on the training sequence;

a second fast transform function arranged to generate a channel impulse response spectrum in the transform domain for the channel impulse response;

an equalizer arranged to equalise the packet spectrum with the channel impulse response spectrum to produce an equalised packet spectrum in the transform domain; and

an inverse transform function arranged to convert the equalised packet spectrum into time domain equalised data for recovery of information.

18. The integrated circuit of claim 17, wherein the equalizer further includes:

a deconvolving function arranged to deconvolve transmitted and received data streams with respect to channel impulse response spectra, thereby to produce at least one equalised data stream.

19. An equaliser comprising:

a first input for receiving a data stream generated from a plurality of space time coded (STC) data streams received from a plurality of transmit antenna elements;

a processor arranged to select a sub-slot of data from the data stream and to implement a fast transform on the sub-slot to generate a packet spectrum for the sub-slot of data, the packet spectrum being a transform domain representation;

means for storing a channel impulse response spectrum generated from a fast transform of a channel impulse response of a channel through which the data stream has been sent, the channel impulse response spectrum being in the transform domain;

a least squares spectral ratio comparator coupled to receive the packet spectrum and the channel impulse response spectrum, the least spectral ratio comparator having an output providing an equalised packet spectrum in the transform domain; and

means for converting the equalised packet spectrum into time domain equalised data for recovery of information.

20. The equaliser of claim 19, further includes:

means for deconvolving transmitted and received data streams with respect to channel impulse response spectra, thereby to produce at least one equalised data stream.

21. The equaliser of claim 19, further comprising means for truncating the channel impulse response spectra to limit processing and enhance accuracy associated with equalising the packet spectrum.

22. (cancelled)

23. The equaliser of claim 19, further comprising a memory storing a matrix-valued channel impulse response.

24. The equaliser of claim 19, the equaliser coupled to receive the data stream through a plurality of receive antenna elements.

25. The equaliser of claim 19, wherein the first and second fast transforms are Fourier transforms.

26. The equaliser of claim 19, wherein the data stream includes the training sequence.

27. The equaliser of claim 19, wherein the data stream is selected from a group comprising: STTD signals; transmit diversity signals; and STC signals.

28. A radio communication device comprising the equaliser having:

a first input for receiving a data stream generated from a plurality of space time coded (STC) data streams received from a plurality of transmit antenna elements;

a processor arranged to select a sub-slot of data from the data stream and to implement a fast transform on the sub-slot to generate a packet spectrum for the sub-slot of data, the packet spectrum being a transform domain representation;

means for storing a channel impulse response spectrum generated from a fast transform of a channel impulse response of a channel through which the data stream has been sent, the channel impulse response spectrum being in the transform domain;

a least squares spectral ratio comparator coupled to receive the packet spectrum and the channel impulse response spectrum, the least spectral ratio comparator having an output providing an equalised packet spectrum in the transform domain; and

means for converting the equalised packet spectrum into time domain equalised data for recovery of information.

29. An equaliser comprising an input, a Random Access Memory (RAM) block, a RAM sample block, a spectrum ratio calculator having a first input connected to the RAM sample block and a second input connected to a RAM having an impulse response spectrum;

wherein the equaliser is operable to:

receive a data stream generated from a plurality of space time coded (STC) data streams received from a plurality of transmit antenna elements;

fill a RAM memory block; converting the data stream by way of a fast Fourier transform operation to provide a sample RAM block Y_k (packet spectrum) and providing the data stream to a first input of an equaliser; and

receive, at a second input of the equaliser, an impulse response spectrum held within the RAM, which impulse response spectrum is a fast Fourier transform of the channel impulse response;

thereby to equalise the data stream whereby to provide an equalised packet spectrum which undergoes an inverse fast Fourier transform to provide equalised packet waveforms.

Evidence Appendix and Related Proceedings Appendix

There is no evidence appendix or related proceedings appendix.